Kentucky

Agricultural Experiment Station

University of Kentucky

THE CONTROL OF FRUIT PESTS

BULLETIN NO. 353

Lexington, Ky.

October, 1934

(201)

EXPERIMENT STATION STAFF

BOARD OF CONTROL

Richard C. Stoll, Chairman, Lexington, Ky.
R. G. Gordon, Louisville, Ky.
James Park, Lexington, Ky.
Joe B. Andrews, Covington, Ky.
Miller Holland, Owensboro, Ky.

Frank L. McVey, President

Thomas P. Cooper, Dean and Director

ADMINISTRATION

T. P. Cooper, Director
D. H. Peak, Business Agent
O. L. Ginocchio, Secretary

AGRONOMY

George Roberts, Head
E. J. Kinney, Assoc. Agronomist
P. E. Karraker, Asst. Agronomist
J. F. Freeman, Asst. Agronomist
W. D. Valleau, Plant Pathologist
E. N. Fergus, Asst. Agronomist
J. B. Kelley, Agricultural Engineer
E. M. Johnson, Asst. Plant Path.
C. E. Bortner, Assistant

ANIMAL HUSBANDRY GROUP

E. S. Good, Chairman
W. S. Anderson, Horses
E. J. Wilford, Swine, Meats
W. J. Harris, Beef Cattle
J. Holmes Martin, Poultry
Fordyce Ely, Dairy Husbandry
W. C. Eskew, Cream Grading
J. W. Nutter, Dairyman
Amanda Harms, Asst. Path. Bact.
G. D. Buckner, Animal Nutrition
W. M. Insko, Jr., Asst. Poultry Husb.
E. A. Baute, Poultry Improvement
Harold Barber, Head Herdsman

ANIMAL PATHOLOGY

W. W. Dimock, Head
Philip R. Edwards, Bacteriologist
F. E. Hull, Asst. Veterinarian
D. J. Healy, Bacteriologist

CHEMISTRY

J. S. McHargue, Head
S. D. Averitt, Chemist
O. M. Shedd, Chemist
W. R. Roy, Asst. Chemist
Robert K. Calfee, Asst. Chemist
David W. Young, Assistant

CREAMERY LICENSE SECTION

J. D. Foster, Inspector, in Charge
N. J. Howard, Inspector

ENTOMOLOGY AND BOTANY

W. A. Price, Head
Mary L. Didlake, Asst. Entomologist
H. H. Jewett, Research Asst. Entgst.
Jessie Taylor, Seed Analyst
C. O. Eddy, Assoc. Entomologist
E. C. Vaughn, Seed Improvement
Encil Deen, Seed Inspector
Howard G. Tilson, Nursery Inspctr.

FARM ECONOMICS

W. D. Nicholls, Head
W. L. Rouse, Farm Management
Z. L. Galloway, Farm Management
Merton Oyler, Rural Life Studies
Geo. B. Byers, Farm Organization
Bruce Poundstone, Farm Management

FEED CONTROL

J. D. Turner, Head
H. D. Spears, Chemist
W. G. Terrell, Inspector
Fred Fitschen, Inspector
L. V. Amburgey, Microscopist

FERTILIZER CONTROL

H. E. Curtis, Head
Harry Allen, Chemist
Lelah Gault, Assistant Chemist
Robert Mathews, Inspector

HOME ECONOMICS

Statie Erikson, Head
Ruth Boyden, Assistant

HORTICULTURE

A. J. Olney, Head
C. S. Waltman, Assistant
E. M. Emmert, Assistant

MARKETS AND RURAL FINANCE

H. B. Price, Head
Dana G. Card, Prices
Clifton J. Bradley, Rural Finance
C. D. Phillips, Markets
Olin M. Farrington, Markets

PUBLIC SERVICE LABORATORY

L. A. Brown, Head
A. L. Meader, Asst. Chemist
James H. Martin, Asst. Chemist
Geo. S. Terry, Bacteriologist
Harvey Cunov, Asst. Bacteriologist
Todd Green, Asst. Bacteriologist

ROBINSON SUBSTATION
(Quicksand, Ky.)

R. W. Jones, Superintendent
G. H. Wiggin, Forester

WESTERN KY. SUBSTATION
(Princeton, Ky.)

S. J. Lowry, Superintendent
L. M. Caldwell, Assistant

CONTENTS

	Page
Insecticides and fungicides	206
Lead arsenate, calcium arsenate, fluorine compounds, residue	206
Zinc sulfate	206
Lime, lime sulfur, wettable sulfur	207
Bordeaux mixture	207
Nicotine	207
Summer oil emulsion and nicotine	208
Fixed nicotine	208
Adhesives and spreaders	208
Tank-mixed oil emulsions	209
Commercial oil emulsions and miscible oils	211
Coal tar oil sprays	211
Apple spray schedule	212
Pests of the apple	215
Codling moth	215
Apple leaf skeletonizer	216
San Jose scale	216
Apple scab	216
Fire blight	218
Blotch	218
Sooty blotch	219
Bitter rot	219
King David fruit spot	219
Black rot	220
Peach spray schedule	221
Pests of the peach	222
Curculio	222
Oriental fruit moth	224
Peach-tree borer	224
Shot-hole borer	226
San Jose scale	226
Brown rot	227
Peach-leaf curl	227
Peach scab	228
Bacterial spot	229
Plum	229
Cherry spray schedule	230
Pests of the cherry	231
Leaf spot, brown rot	231
Curculio	231
Aphids, slugs, scale	231
Grape spray schedule	232
Protection by sacking	233

Page
Pests of the grape 233
Black rot 233
Berry moth 234
Flea beetles 234
Leaf folder 234
Green June beetle 234
Leafhoppers 234
Root worm 235
Scale 235
Strawberry 236
Crown borer 236
Leaf roller 236
White grubs 236
Leaf spot 237
Raspberry 237
Leaf spot 237
Anthracnose 238
Red spider 239
Currant and gooseberry spray schedule 239

BULLETIN NO. 353

The Control of Fruit Pests

By C. O. EDDY, W. D. VALLEAU and W. W. MAGILL

Insects that attack fruit may be divided into two classes; chewing insects and sucking insects. The chewing insects, such as curculio, caterpillars, and the larvae of the codling moth and oriental fruit moth, eat fruit or foliage or both. These insects can be destroyed by poisons placed on their food. For instance, if lead arsenate is sprayed on apples, the larvae of the codling moth eat it in burrowing into the apple and are killed. The sucking insects, such as aphids, leafhoppers and San Jose scale, pierce plant tissues with stylet-like mouth parts and draw their nourishment from beneath the surface. Thus they escape a poison placed on the plant surface. Therefore, it is necessary to apply a poison that kills if it comes in contact with the insect. Nicotine is such a "contact" poison, used in spray or dust, to kill aphids and leafhoppers. Oil emulsion destroys scale insects by contact.

Some diseases are caused by minute forms of plant life which live parasitically on the fruit, foliage, or other parts of the plant. Apple scab and brown rot of peach are examples. The organisms usually penetrate the plant tissues so it is often impossible to destroy them by either spraying or dusting, after infection has occurred. Plant diseases of this type may be prevented by spraying. For example, apple trees are sprayed periodically with lime-sulfur solution from the time the earliest buds appear until a few weeks after blossoming, to protect against apple scab.

The grower should exercise care in selecting spray material, thoroness in applying it and discretion in the frequency and time of application. The details of spraying are so various

for different crops, insects, diseases, and seasons, that the beginner may think the task of controlling insects and diseases difficult. However, with a knowledge of the fundamental principles of spraying and of insect and disease control, he will find this branch of orchard management relatively easy.

INSECTICIDES AND FUNGICIDES

Lead Arsenate. This is the most common insecticide now in use by orchardists. It is sold in the form of white powder. It is extremely poisonous, not only to insects, but to animals and man, hence great care should be used in handling and storing it.

Lead arsenate is used to destroy codling moth larvae (worm in apple), curculio, potato beetles, and many other chewing insects. It is commonly used at the rate of one or two pounds to fifty gallons of water, together with twice its weight of hydrated lime. It may be added safely to Bordeaux mixture or to liquid or dry lime sulfur. Lead arsenate and a little water should be made into a thin paste free from lumps before adding to the spray tank.

Calcium Arsenate. This poison has proved generally unsatisfactory in Kentucky for spraying fruit trees because of its tendency to burn the foliage and its failure to give adequate control.

Fluorine Compounds. The use of these materials as substitutes for lead arsenate has proved unsatisfactory in Kentucky thus far.

Residue. The 1935 spray residue ruling of the U. S. Department of Agriculture states that interstate shipments of fruits carrying more than .01 grain of arsenic trioxide or more than .018 grain of lead per pound of fruit are subject to seizure. The tolerance for fluorine is .01 grain per pound of fruit.

Zinc Sulfate. Zinc sulfate and lime are used to reduce the injurious effect of lead arsenate on peach foliage. In preparing it, run a few gallons of water into the tank, and add the zinc sulfate. As the tank is filling add the lime (previously made to

a thin paste) thru the strainer. Then add wettable sulfur, if required, and lead arsenate when the tank is nearly full.

Lime. Lime for spraying should be "chemical" hydrated lime. Other hydrated lime may contain impurities which may injure fruit, foliage, or the spraying equipment.

Lime Sulfur. For scale insects and for peach leaf curl the trees should be sprayed while dormant with a mixture of one part of liquid lime sulfur to 8 parts of water. As a fungicide for summer spray on apples the dilution is one gallon to 50 gallons of water. Dry lime sulfur may be used as a dormant spray if the manufacturer's directions are followed. As a summer spray use four pounds in place of each gallon of liquid lime sulfur. Lime sulfur should not be used as a summer spray on peaches.

Wettable Sulfur. Wettable sulfur is sulfur that has been treated with a wetting agent so that it mixes freely with water. When used with zinc sulfate, the sulfur should be added to the mixture before the lead arsenate. Wettable sulfur is sold in Kentucky under various trade names.

Bordeaux Mixture. To prepare 8-10-100 Bordeaux Mixture dissolve 8 pounds of finely powdered bluestone (copper sulfate) in a wooden or granite ware bucket of water (if in crystals, use hot water and suspend in cloth sack 2 inches into the water). Mix 10 pounds of chemical hydrated lime into a thin paste and strain into the tank or barrel containing 50 to 60 gallons of water. Dilute the bluestone solution to 8 or 10 gallons and add it to the lime water, stirring well. If poison is to be added, stir 3 pounds of lead arsenate into a paste, dilute, and pour it into the spray tank while stirring. Make up to 100 gallons.

For 3 gallons. If only a small amount of Bordeaux is needed use 4 ounces of bluestone, 5 ounces of chemical hydrated lime, 1½ ounces of lead arsenate, and 3 gallons of water, and mix as directed above. Use Bordeaux mixture while fresh.

Nicotine. Solutions containing 40 percent nicotine as nicotine sulfate or 50 percent free nicotine are on the market. Dusts containing nicotine are for sale, also. Nicotine is a con-

tact insecticide used for control of plant lice, thrips, leafhoppers, and other soft-bodied insects. The usual dilutions of nicotine sulfate or free nicotine (50 percent) range from ½ to 1 pint per 100 gallons. A spreader is usually necessary with nicotine and it is advisable, especially with low-power or hand equipment, to use sufficient so that the liquid spreads over the leaves and insects without forming droplets. Soap should not be used with lime sulfur and nicotine but calcium caseinate is safe.

Summer Oil Emulsion and Nicotine. Specially refined mineral oils commonly called "summer oils" for use in making spray emulsions are on the market. These oils when combined with nicotine make one of the most promising substitutes for lead arsenate in codling moth control. The cost is high and it is necessary to apply this spray more frequently than lead arsenate. Summer oil with nicotine kills eggs of the codling moth as well as larvae and is used for the control of leafhoppers. Summer oil emulsion is a valuable adhesive for lead arsenate when used at the rate of ½ gallon of actual oil to each 100 gallons.

Fixed Nicotine. Combinations of free nicotine with bentonite or with bentonite-sulfur mixtures are being tested extensively for the control of codling moth worms. These combinations are giving very effective control when used with an adhesive. Their cost, however, is high. Tests at the Experiment Station at Lexington showed these combinations had no value in the control of grape leafhoppers.

Adhesives and Spreaders. These are substances added to make the spray solution spread out on the surface of fruit, leaf, stem or insect, instead of standing in drops, and to keep the poison from being washed off by rain. Their use renders the spray more effective. In areas where codling moth is numerous it is necessary to spray fruit trees with lead arsenate and an adhesive and spreader. The materials that appear to be best adapted for use in Kentucky are raw linseed oil, fish oil (specially refined), summer oil emulsion, and neutral soap spreaders made for use with arsenicals. Special directions must be fol-

lowed and precautions taken in using each of these materials if insect control is to be improved and injury avoided.

For spraying grapes raw linseed oil, fish oil (made for spraying), or soap are satisfactory spreaders. The oils should be used at the rate of one pint to 100 gallons. One pound of hard spray soap containing from 80 to 95 percent of anhydrous soap or 2 pounds of liquid soap containing 35 to 40 percent of anhydrous soap, should be used per 100 gallons.

Liquid cocoanut oil soap is a good, economical spreader. Potassium oleate and sodium oleate are satisfactory but cost more. When buying liquid soap, the actual soap content should be determined. Cocoanut oil soap (liquid) and potassium oleate (liquid) should contain 40 percent of anhydrous soap. Sodium oleate usually contains 20 percent of anhydrous soap. Cocoanut oil soap and potassium oleate, which contain 60 percent anhydrous soap, are sold as pastes. There are several brands of hard soap chips that are especially manufactured for use as insecticides and spreaders. In 1933 these were shown to be several times more effective than laundry and general-purpose soaps when used with nicotine in control of grape leafhoppers. The hard soaps must be dissolved with heat and therefore are not so convenient to use as liquid soaps. They usually contain from 80 to 90 percent of anhydrous soap.

Tank-Mixed Oil Emulsions. Tank-mixed 2 percent oil emulsions, as used in Kentucky, cost about 40 cents for 100 gallons and are highly satisfactory as dormant sprays.

Lubricating oils for spraying should have the following specifications: Viscosity between 125 and 200 seconds, Saybolt, at 100 degrees Fahrenheit; volatility less than 2 percent in four hours at 105 degrees Centigrade. These oils are sold by oil companies at their bulk stations under such names as "agricultural spray oil", "orchard spray oil", "scale oil", etc., at about 15 to 20 cents per gallon.

FORMULAS FOR APPLES

For 50 gallons (hand pump)		For 100 gallons (power pump)	
Oil	1 gal.	Oil	2 gals.
Calcium caseinate	5 ounces	Calcium caseinate	6 ounces
Water to make	50 gallons	Water to make	100 gallons

To mix 50 gallons of solution for apples (barrel sprayer):

1. Mix 5 ounces of calcium caseinate in a 2 or 3 gallon bucket with ½ pint of water, making a thick paste. Gradually dilute until the bucket is full. This step is important.

2. Put the calcium caseinate mixture into the spray tank and add sufficient water to operate pump—usually 2 or 3 gallons.

3. Start pumping and allow the discharge from the open spray rod to flow back into the tank under full pressure.

4. Add 1 gallon of oil (continuing agitation) and pump for a few minutes; then fill the tank with water. Apply the spray immediately.

Power spray pumps are more satisfactory than hand pumps for making tank-mixed emulsions. The procedure is the same, but in mixing with the power pump, less calcium caseinate is required.

FORMULAS FOR PEACHES

The spray mixture is the same as for apples, except that 6-6-100 Bordeaux Mixture is added instead of water, after the oil is emulsified. The experienced commercial peach grower may omit the calcium caseinate by emulsifying the mineral oil in a concentrated Bordeaux mixture made of 2 pounds of bluestone, 5 pounds of chemical hydrated lime, and about 7 gallons of water; then, while filling the tank, add 4 pounds of bluestone and 1 pound of hydrated lime to 100 gallons, making 6-6-100 Bordeaux.

To mix 50 gallons of solution for peaches (barrel sprayer): Emulsify the oil with calcium caseinate as for apples, fill the tank 2/3 full and, while pumping, add 3 pounds of chemical hydrated lime and 3 pounds of copper sulfate, previously mixed in separate buckets of water. Fill the tank with water. Apply the spray immediately.

Commercial Oil Emulsions and Miscible Oils. The proprietary brands of oil emulsion and miscible oil have given satisfactory control of San Jose scale.

Coal Tar Oil Sprays. Coal tar oil sprays have been used in the East for about five years. These oils kill the eggs of rosy aphis and have some effect on scale. Most of the commercial tar sprays, of which several are on the market, have mineral oil in them for the purpose of controlling scale. These oils have been used in Europe for many years as dormant washes at nearly twice the concentration recommended in the United States. The use of tar oils in the United States is still in the experimental stage. They are suggested for trial in Kentucky.

THE APPLE SPRAY SCHEDULE*

Time	Spray Mixture	For
**Dormant	Oil emulsion 2% or Liquid lime sulfur 1 to 8 or Dry lime sulfur 30 lbs. to 100 gals.	San Jose Scale
Tips of flower buds exposed	Lime sulfur 2½ gals. Water 100 gals.	Scab
*Pre-pink, before cluster buds separate	Lime sulfur 2½ gals. Water 100 gals.	Scab
**Pink, clusters separated	Lime sulfur 2½ gals. Water 100 gals.	Scab
Full bloom (1/3 bloom open)	Bluestone 2 lbs. Hydrated lime 6 lbs. Water 100 gals.	For blossom blight, on susceptible varieties, and scab
**Calyx spray (when petals are 3/4 off)	Lime sulfur 2 gals. Hydrated lime 6 lbs. Lead arsenate 3 lbs. Water 100 gals.	Scab Codling moth
First Generation Codling Moth *First cover, 2–3 weeks after calyx	(See discussion of midway spray) Lead arsenate 3 lbs. Lime sulfur 2 gals. Hydrated lime 6 lbs. Water 100 gals.	Codling moth worms. For sooty blotch, blotch-susceptible varieties and King David, use arsenate and 6–8–100 Bordeaux
*Second cover, 2 weeks later	Lead arsenate 4 lbs. Hydrated lime 8 lbs. Water 100 gals. Adhesive suggested, such as 1 pint to 1 quart raw linseed oil	Codling moth worms. For sooty blotch, King David, or for blotch-susceptible varieties use 4–6–100 Bordeaux and 4 lbs. lead arsenate
Third cover, 2 weeks later	Lead arsenate 3 to 4 lbs. Hydrated lime 6 to 8 lbs. Water 100 gals. Adhesive suggested, such as 1 pint to 1 quart raw linseed oil	Codling moth. For blotch use 4–6–100 Bordeaux and 3–4 lbs. lead arsenate. If bitter rot has been a factor see page 219

THE APPLE SPRAY SCHEDULE*—(Continued)

Time	Spray Mixture	For
***Second Generation Codling Moth** First cover (see notes on timing, on following page)	Lead arsenate 3 lbs. Bordeaux 8–10–100	Second generation codling moth worms Bitter rot
Second cover, 2 weeks later	Lead arsenate 3 lbs. Hydrated lime 6 lbs. Water 100 gals.	Codling moth worms
Third cover, 2 weeks later	Lead arsenate 3 lbs. Hydrated lime 6 lbs. Water 100 gals.	Codling moth worms

*To assist the home or small orchardist who does not require or is not able to put on a full spray schedule, the important sprays have been starred in the schedule. The most important sprays are starred twice and are often adequate. Most commercial orchards need all starred sprays, whereas in areas heavily infested with codling moth, such as Henderson, the complete schedule is needed.

NOTES

In orchards where scale is moderate to heavy, the formula for oil spray should be modified by using 3 gallons of mineral oil and 9 ounces of calcium caseinate in each 100 gallons, thus making a 3 percent rather than a 2 percent oil emulsion.

If temperatures are comparatively high, apply first cover spray for first generation codling moth worms 10 days to 2 weeks after calyx spray. If temperatures are comparatively low, apply a scab spray of 2-100 lime sulfur 7 to 10 days after calyx spray, and apply first cover 2 to 3 weeks after calyx spray. If curculio is a factor, as in eastern Kentucky, apply 4 pounds of lead arsenate, 8 pounds of hydrated lime and 2 gallons of lime sulfur with water to make 100 gallons, 7 to 10 days after calyx spray.

Four pounds of dry lime sulfur are approximately equivalent to one gallon of liquid lime sulfur, in summer sprays.

TOPPING. Spraying only in the tops of trees, between the first and second, and again between the second and third covers, for the first brood, is necessary in orchards where the infestation is exceptionally heavy.

If an adhesive is to be used in second and third cover for first-brood worms, use Bordeaux in place of lime sulfur in first cover.

SUPPLEMENTAL CONTROL OF CODLING MOTH. 1. Remove apples from orchard as soon as picked. 2. Keep orchard free of all debris. 3. Use poison bands to supplement spraying. 4. Removal of neglected apple trees in the neighborhood is very helpful.

REDUCE SPRAY RESIDUE. Fertilize, prune and thin apples so that large fruits are produced. This reduces the relative amount of arsenic and lead per pound of fruit. Thin and destroy fruit when most wormy, in June and again in late July or early August.

TIMING SECOND-GENERATION CODLING MOTH WORM SPRAYS.

Paducah Section. Apply first cover spray for second generation worms during last week of June, in average years, or as

directed by county agents. Apply other cover sprays at two-week intervals. Third cover spray is not necessary except where codling moth infestation is high.

Henderson-Bowling Green. Apply first cover spray for second generation worms during three or four days immediately after fourth of July, in average years, or as directed by county agents. Apply other covers at two-week intervals if rains do not interfere. No cover sprays can be safely omitted in the Henderson region. In the Bowling Green area the third cover spray is normally not necessary.

Louisville and Eastern Kentucky. Apply the first cover spray for second-generation worms about July 12 and a second cover spray two weeks later. A third cover, even in commercial areas, is normally not necessary.

PESTS OF THE APPLE

Codling Moth. The common worm in apples is the larva of the codling moth. The adult is a small, gray moth which sometimes may be seen at twilight, flying about apple or pear trees where it lays eggs when the temperature is 60° F. or above. In Kentucky, apples are the only host of importance, tho occasionally pears need a calyx spray for this worm. Wild crab-apples and hawthorns are native hosts. Early in the season the small, disk-shaped, glistening eggs are deposited on the under side of the leaves (occasionally on top) or on twigs or flowers, but later, on the fruit almost entirely. The worms or larvae, which hatch from these eggs, sometimes feed on a leaf, but soon enter the fruit. The early worms enter the apple thru the calyx. These are known as "calyx worms". Later, worms enter thru the sides of the apple and are called "side worms". Some years practically all the worms enter thru the sides, whereas other years enough worms enter by way of the calyx to destroy as much as 60 percent of the crop. Stings are caused by worms that burrow thru the skin and die from poison or natural causes. Wormy apples fail to grow to normal size, fall before maturity or ripen prematurely. After a period of feeding the larva leaves the fruit to pupate in a silken cocoon,

most frequently under loose bark on the trunk or in debris at the base of the trunk. The codling moth passes the winter in the larval stage, in a cocoon. Beginning about July some of the larvae spin cocoons in which to pass the winter. The percentage of larvae that do this steadily increases as the season advances, until, in the late season, all the larvae prepare in this way to hibernate. In the spring, the larvae transform thru the pupal stage into moths, which mate and lay eggs for the first-brood worms. These begin entering the fruit about ten days to three weeks after petal fall. These worms pass speedily thru the larval and pupal states and mature into adult moths which commence laying eggs about the first of July, for the second-brood worms. A partial third brood follows in August, and sometimes there is a partial fourth brood. Thus is produced the succession of broods which the orchardist must combat.

Apple Leaf Skeletonizer. Skeletonizing the leaves in the tops of apple trees is done by a worm, the adult of which is a moth. It is injurious where spraying has not been done thoroly on the top branches.

San Jose Scale. This is a sucking scale-like insect which causes injury to the fruit and bark of the apple, peach and other deciduous fruits. The scales are minute round or oval, flattened bodies which appear, when in large numbers, as a grayish scurf on the bark of trees. On fruits and young bark, small red or reddish-yellow, circular spots are formed by the insect. The young move about freely but finally settle in one place and develop into adults. The males finally become winged and fly about. Scale is controlled by a dormant spray of oil emulsion or lime sufur.

Apple Scab. The apple scab fungus causes several types of injury. On leaves it produces a superficial olive-greenish spot which frequently ends in death of the affected part or of the whole leaf. Early spring infections on the calyx lobes, or sepals, of flower buds not yet showing pink, may shed spores on the developing fruit, resulting in distorted apples with the characteristic black spots on one side of the blossom end. Infections on the fruit stems during blooming result in dropping of the

blossoms of some varieties. Other varieties, as the Kinnaird, appear to be highly resistant to this type of injury.

Infections following the blooming period cause the black spots scattered over the surface of the fruit. The disease develops best in cool weather; comparatively few infections take place in warm weather, altho the spots continue to increase in size with the development of the fruit.

The scab fungus overwinters on leaves infected during the fall. Black, spherical fruiting bodies develop during the winter on leaves on the ground. Some spores may be mature at the time the earliest varieties begin to bloom unless this period is preceded by dry weather. If, because of dry weather, spores are not mature when growth commences, some spores may be expected to mature with the first heavy rain and be discharged during the following rain. The spores are shot with some force into the air when the dead leaves are wet. Thus infection may occur at any time following exposure of green parts if spores are mature and there is sufficient rain to wet the old leaves. Secondary spores are produced in a few days on the new infections and from these the disease may spread as the buds advance. Failure to prevent infection during the prepink stage of blooming appears to have resulted in much scabby fruit, especially on Delicious, and loss of crops in the past in Kentucky.

Prevention. Protection of the early-blooming varieties, as Delicious, with a spray applied soon after the tips of the flower buds appear, with constant protection thru the blooming period, appears to be essential for control of scab, especially when rains are frequent. If weather reports indicate continued dry weather during early bloom, spraying may be delayed until rains are indicated, when a spray should be applied immediately. This procedure may not be safe when several days are required to cover the orchard, in which case it is safer to follow a more complete schedule. Weak Bordeaux mixture applied during the blooming period, for blight control, may also assist in preventing infection of the fruit stems. Timeliness with respect to

rains, in order to prevent primary infections, appears to be all-important in scab control.

Fire Blight. This bacterial disease of the apple and pear is destructive some years and may then seem to disappear nearly entirely, for a time. The cause of this irregularity is not fully understood. Blossom clusters destroyed by blight, turn black and remain on the tree, in contrast with frost-injured blossoms which are not killed outright, but fall after blooming. Twig blight is common, giving the tree the appearance of having been scorched by fire. Susceptible varieties of pears and rapidly growing Transparent apples, as well as some other susceptible varieties, may have whole limbs destroyed by blight. Old Transparent trees are usually free from this type of injury. There appears to be a direct relation between overwintering cankers on pear trees, and to a much less extent on apples, and blossom blight. Complete removal of all dead wood and bark from pear trees in the vicinity of apple orchards each winter is recommended. Promising results have been obtained in increased set of fruit, in years when blossom blight was abundant, by spraying a weak Bordeaux mixture (1-3-50) directly into the blooms when about 1/3 of the blossoms are open. This spray is recommended where blight is a factor and may aid in scab control, especially when the blooming period is extended.

Blotch affects comparatively few varieties of apples commonly grown in Kentucky. Among the more susceptible are Oldenburg, Maiden Blush, Gano, Ben Davis and Rome Beauty. The blotch fungus attacks the fruit, producing more or less circular, superficial, radiating black spots. These may remain superficial, but on very susceptible varieties the tissues are killed and the spots become sunken and black by picking time. Frequently small, black pimples, the fruiting bodies, develop in the spots. Leaf infections occur, being most prominent on the under side of the mid-vein and on the leaf stem as small dead areas. Infection at the base of the leaf stem may spread into the twig producing a canker about the bud. These cankers may produce spores for several years. As canker prevention is essential in the control program, spraying for blotch on susceptible

varieties must be done each year, crop or no crop. Infection spreads from fruiting bodies on the rough twig cankers, beginning about two weeks after petal fall and continuing for about 6 or 8 weeks. Protection of susceptible varieties is essential during this period. Bordeaux mixture as recommended in the three cover sprays for the first-generation codling moth controls blotch and helps in bitter rot control. For control where blotch is a minor factor, lime sulfur may be used.

Sooty Blotch is a fungus disease of apple which results in a sooty appearance of the skin of the fruit in August or later. It is entirely superficial but injures the appearance of the fruit. The disease is likely to be severe in any orchard which is surrounded by a natural growth of trees and shrubs several of which are hosts of the fungus. In Indiana it was found that Bordeaux mixture added to the first and second cover sprays for first-generation codling moth was effective in control.

Bitter Rot. This disease usually appears during humid, hot periods, as brown, rotten spots which have a flat surface. Spread by insects such as flies is rapid. Removal and destruction of the first affected fruits and the destruction of the overwintering fungus (in mummied fruits, fruit stems, cankers) usually located above the first rotten fruits, aids in control. In orchards where the disease rarely occurs a Bordeaux spray applied in the first cover spray for second-generation codling moth in late June or early July goes a long way towards preventing its recurrence. Where it has been injurious during the past 2 or 3 years, Bordeaux mixture should be used in the third cover spray for first-generation codling moth and in the three sprays given in the spray schedule for the second-generation codling moth; that is, at two-week intervals beginning about the middle of June and continuing until four sprays have been used.

King David Fruit Spot. The King David variety is affected by a fruit spot (Brook's fruit spot) which makes its appearance in August. Other varieties do not appear to be extensively affected by this disease in Kentucky. The spots are small, irregular, greenish to black in color and after harvest the affected tissue, to a very shallow depth, dies and turns black.

The disease is apparently identical with Brook's fruit spot or phoma fruit spot which is injurious to many other varieties farther north. It is claimed that the fungus produces a perfect or wintering stage on dead leaves on the ground, from which the spores are discharged. Infection appears to take place 4 to 6 weeks after petal fall, but the spots do not appear on the fruit until late in the summer. Studies conducted in southern Ohio and elsewhere indicate that best control is obtained by spraying with Bordeaux mixture in the first and second cover sprays for the first-generation codling moth.

Black Rot. This fungus sometimes causes a black rot of the blossom end of Stayman and some other varieties of apples about three-fourths grown. This appears to follow arsenic injury. Leafspot due to the same fungus is quite common on apple trees and usually may be traced directly to a mummied fruit or to a dead twig or branch which will be found to be covered with the fruiting bodies of this fungus. Removal of mummied fruits and dead wood, together with the regular spray program, controls this disease.

THE PEACH SPRAY SCHEDULE

Time	Spray Mixture	For
*Dormant season before buds swell	Tank-mixed oil Bordeaux or Liquid lime sulfur 1 to 8 or Dry lime sulfur 30 lbs. to 100 gals.	Scale Leaf curl
Shuck fall spray, 75% shucks off	Lead arsenate 2½ lbs. Hydrated lime 8 lbs. Zinc sulfate 8 lbs. Water 100 gals.	Curculio. Omit if no curculio present, or spray in spots for scattered infestations.
*Month after petal fall or 10 days after shuck fall. This spray should not be postponed	Lead arsenate 2½ lbs. Hydrated lime 8 lbs. Zinc sulfate 8 lbs. Wettable sulfur 6 lbs. Water 100 gals.	Scab. Curculio. If jarring shows no curculio, omit arsenate, lime and zinc.
Two weeks later if jarring indicates the need	Lead arsenate 2½ lbs. Hydrated lime 8 lbs. Zinc sulfate 8 lbs. Water 100 gals.	Curculio. Use as jarring results indicate.
*Three weeks before harvest	Wettable sulfur 6 lbs. Water 100 gals.	Brown rot
*Just before harvest	Wettable sulfur 6 lbs. Water 100 gals.	Brown rot

*Starred sprays may be used as a fixed schedule where jarring is not practiced.

NOTES

Care should be taken to get pure chemical hydrated lime. Zinc sulfate in these sprays is recommended to reduce arsenical injury. Wettable sulfur is sold in Kentucky under various trade names.

MIXING. Run a few gallons of water into the tank, then add the zinc sulfate. As the tank is being filled add the lime (previously made into a paste) thru the strainer, then add the wettable sulfur, if required, and finally add the lead arsenate when the tank is nearly full.

For effective control of the curculio, sprays should be supplemented by jarring the adults from the trees, both as a means of control and as an indication of when and where to spray; and by picking up and destroying dropped peaches. Apply lead arsenate only when the trees and foliage are dry and do not apply sprays when the temperature is above 90° F. Otherwise, there is danger of burning.

CAUTION. Lime sulfur and Bordeaux mixture should not be used as summer sprays on peaches.

LATE POISON SPRAYS. Peaches sprayed with lead arsenate a week or even two or three weeks before harvest will have residues above the tolerance allowed by the United States Department of Agriculture. To avoid the necessity of the preharvest poison spray follow the system of jarring and picking up drops recommended.

PESTS OF THE PEACH

Curculio. The adult curculio is a small, grayish-brown snout beetle with rough humps and white spots on its wings. The adult hibernates in grass, weeds, debris, along fences, plum thickets and in rubbish in and around orchards. Cleaning up or burning such areas kills many of the hibernating insects, and aids in checking the damage of this pest. This measure of control should never be neglected. There are two generations each year; the larvae of one generation develop in the small peaches or plums, and those of the other in ripening fruit. The curculio

has four stages: the egg (laid in the fruit); the grub or larva (the legless worm in the fruit); the pupa (in the soil); and the adult beetle.

Sprays for curculio should be applied only if the curculio is present in the peach orchard in numbers sufficient to warrant a spray (plums rarely escape curculio injury). Each grower should inform himself by "jarring" as to the exact situation in his orchard and spray when and where these results indicate. If no curculio are present no poisons are necessary. Later he should pick up and destroy all drops, where curculio are indicated either by jarring or by cutting of dropped peaches. This program saves both time and money, as compared with following a fixed spray schedule.

Drops. Curculio cause the fruit to drop during two periods. The first drop results from punctures made in the peaches by the over-wintered beetles. The stung peaches usually reach a diameter of ½ inch or more, and have a drop of wax over the injury. The second drops are caused by second-generation curculio worms which result in the fruit ripening prematurely and falling just before harvest.

The drops should be picked up twice each week during these two periods. Stung peaches that do not drop should be picked off while thinning. The curculio grub may be killed by submerging the peaches in water for several days. Picking up and destroying the first drops is most important and, if thoroly done, ensures nearly a worm-free crop at harvest time. Curculio control aids in reducing brown rot, as this disease frequently follows insect injury in ripening fruits. Destruction of wormy ripening fruit reduces the number of beetles that hibernate and helps to protect the crop of the following year.

Jarring for Curculio. The curculio appears in peach orchards in limited numbers and in rather definite places soon after the temperature averages 60° F. for 4 consecutive days and nights. They may be jarred from the trees on to a sheet early in the morning while cold. In this way overwintering places may be detected, the time for spraying more accurately determined, and the part of the orchard needing spraying may

be determined. The presence of any curculio on the trees in one corner or one side of a peach orchard suggests an overwintering place on that side. It may be a neglected plum tree a long distance off, the destruction of which would greatly aid in control.

Jarring is most effective between daylight and 9 A. M. Jarring should be started on the edge of the orchard near suspected hibernation quarters of the adult curculios and at intervals thru the orchard. Jarring should be done frequently during the three or four weeks following shuck fall. Spread a full-size bed sheet under a peach tree or limb and strike the tree or limb two or three moderately sharp blows with a padded mallet. Destroy the curculios that fall on the sheet and make a record of the number and the tree from which they were jarred.

Curculio usually appear in large numbers on plum trees before they do on peach trees. Consequently, plum trees should be jarred more frequently and regularly than peach trees. Plum trees may serve as a trap if jarring is done regularly. The destuction of wild plum thickets and neglected plum trees located near peach orchards is advisable.

Winter Clean-Up. During the winter, clean up all areas in or around the orchard, where adult curculio may hibernate. Weeds, debris, and rubbish should be burned. Fence rows, plum thickets, creek banks, railroad banks and all similar situations should be cleaned up. These precautions aid in reducing infestation the following season.

The Oriental Fruit Moth. The worm with legs found in peaches is the larva of this insect. It differs from the curculio worm in that the latter has no legs. The Oriental fruit moth also attacks peach twigs causing the tips to die. No satisfactory method is known for the control of this pest.

Peach Tree Borer. The adult peach tree borer is a clear-winged moth which, in Kentucky, lays eggs on the base of the tree trunks from about July 1 until late in September. Eggs hatch in about ten days and the young larvae enter the tree trunk, where they feed until cold weather. They become dor-

mant in the winter but resume active feeding in the spring. They transform to adults in midsummer and these lay eggs for the new generation. There is one generation a year. The larvae injure peach trees near the ground level by tunnelling under the bark and partially girdling the tree. Gum exudes from the wounds and the bark is roughened. The trees may become sickly, have a stunted appearance, and finally die if not treated.

Control. Paradichlorobenzene (PDB) is a white, crystalline substance that has the appearance of coarse salt, with an odor resembling that of moth balls. It is placed about the base of trees in the fall to kill the borers. The fumes from this material, while harmless to persons, are poisonous to insects. Being heavier than air, the PDB fumes readily permeate the soil.

It is desirable that the treatment be made as late in the season as possible and still kill the borers, but it must be done while the ground is warm enough so that the PDB forms a gas. If applied during hot weather, injury may result. The soil temperature should be about 60° F. or above, to be most effective. Application should be made when the soil is dry. Growers should use this information in adjusting suggested dates for the application of the poison. In Eastern Kentucky, PDB should be applied about the middle to late September; in Central Kentucky, late September to early October; in Western Kentucky, October. Adjust the time of application to temperature and soil moisture. Spring treatment with PDB has not given satisfactory control in Kentucky. Where PDB is not applied in the fall, it is recommended that the borers be dug out with a knife during early spring.

Dosage. Trees six years of age and over should receive one ounce of PDB. On 4- and 5-year trees and on unusually large and sturdy three-year-old trees, ¾ ounce should be used. It may not be necessary to treat younger trees. However, in Kentucky and other midwestern states, two- and three-year-old trees have been safely treated with one-half ounce of PDB. It is better to "worm" one-year-old trees by removing the worms from the trunk with a knife and wire or a special instrument.

If growers choose to apply PDB to the one-year-old trees, the dosage should not exceed 1/4 to 1/3 ounce per tree.

Method. To prepare a tree for treatment, grass and debris should be removed from around the trunk and the ground smoothed off. If borers are working much above ground level, draw in some fresh soil and pack it down firmly around the trunk so that the earth is approximately level with the highest borer. The PDB should then be placed around the tree in a ring about one inch from the tree but not nearer. After this, a shovel-ful of well-pulverized soil should be sprinkled carefully over the crystals, from above, in a way to avoid pushing them against the bark. Six or seven additional shovel-fuls should then be placed around the tree and packed to form a cone. Mounds which are formed around the tree usually disappear by the following spring; if they have not, they should be removed. About 95 percent of the borers may be killed by this treatment, whereas hand worming kills only about 50 percent.

Shot-Hole Borer. Frequently the trunks and branches of peach trees are seen to have numerous tendrils of gum exuding from them. This exudes from minute holes formed by the adult borer as it enters to lay eggs or when the adults emerge in completing their life history. The grub-like larvae burrow between the bark and the wood. These insects also affect plum, apple, pear and other deciduous fruits. They work principally in weakened branches and trees, which should be cut and burned. The adult beetle is brownish-black in color, about 1/10 of an inch in length, is cylindrical in shape and has a much reduced snout. There are three or four generations each year.

San Jose Scale. This pest affects peach much as it does apple (See discussion under Apple), except that twig and tree injury is much more severe. A neglected peach orchard usually becomes unproductive or dies out in a few years as a result of insect injury. The San Jose scale usually causes the major injury. Peach tree borer probably ranks second in importance in destroying trees. Shot-hole borer injury increases rapidly when San Jose scale and peach tree borer are numerous.

Brown Rot. Brown rot is a fungus disease best known to the fruit grower as a rot of ripening fruit of peach, plum and cherry. It may cause blossom blight if wet weather prevails during the blossoming period. The fungus attacks leaves and shoots affected by peach-leaf curl, where it may persist and act as a source of infection for the ripening fruit. In dry seasons brown rot may be no factor whatever but if wet weather prevails during ripening, a crop may be destroyed in the course of about three days. If much fruit is rotted and allowed to remain on the tree, fruiting wood for the following year is destroyed by the fungus penetrating the twig and killing it. This type of injury is common in Kentucky.

The fungus which causes brown rot lives thru the winter in rotted or mummied fruit in which the fungus forms large, hard masses known as sclerotia. These mummied fruits may persist on the ground for several years, unless buried, when they are likely to decay. About the blooming period of the peach, mushroomlike growths develop from the partially buried or buried mummies. From the upper surface of these bodies spores are discharged in clouds from time to time. In wet seasons these spores cause blossom blight. Blighted blossoms, infected leaf-curl lesions and perhaps other types of infection carry the fungus thru the summer and furnish spores for infection as the fruits approach the ripening stage. Peaches which ripen prematurely because of curculio injury are likely to decay and furnish an abundant source of spores for the ripening fruits. Thus, curculio control is essential to brown rot control.

Brown rot may be controlled commercially with sulfur sprays or dusts. If a spray is to be used, it should be applied, preferably, about three weeks before ripening. If dust is to be used, dusting may be delayed until the first appearance of the disease or until a few days before harvest, or may be done even during harvest if the disease is increasing. This serves also to protect the fruit during storage or shipment. Removal of all decayed fruit from the orchard at harvest time aids control in following years.

Peach-Leaf Curl. Peach-leaf curl is a disease of peach

leaves which appears soon after the buds open in the spring and persists until the leaves affected at that time have fallen off. In seasons when the disease is particularly severe, leaves on new shoots as far as ten inches from the position of the original bud may be affected, indicating that infection may occur long after the buds open. Affected leaves are thickened, blistered, and very much distorted. In the early stage the affected portions turn red; later on they turn a waxy gray. Severely affected shoots may be attacked and killed by the brown rot fungus. On the waxy surface of affected leaves spores are produced in abundance. These spores are carried by air currents to the twigs and branches where the fungus lives much like a yeast on the bark the remainder of summer and the next winter. A fungicide spray thoroly applied at any time during the dormant season controls the disease. Partial control may be obtained by spraying after the buds have begun to open. The only peach variety which has been observed to be highly resistant to the disease in Kentucky is Mayflower.

Peach Scab. Scab is caused by a fungus closely related to the apple-scab fungus but differing from it in that the fungus of the peach overwinters in small cankers on the young twigs, not in the dead leaves on the ground. The spores develop rapidly in wet periods and are washed from the cankers to the developing fruits. The fungus causes dark greenish to black, freckle-like spots on the upper surface of the fruit, which frequently are so numerous as to blacken this side of the fruit completely. A few scab spots are not injurious but heavy infection may result in cracking and, toward ripening time, wilting, and finally rotting of the affected side of the fruit. Infection takes place during wet periods after the young fruit is about half an inch in diameter. About eight weeks are required, following infection, before the spots become visible. Consequently, early varieties may escape with little apparent infection, even without a spray, while on later varieties, as the Elberta, only early infection must be prevented. On still later varieties, a second scab spray may be necessary about a month after the first. The dis-

ease is easily controlled by one or two sulfur sprays applied about the time the fruits are half an inch in diameter.

Bacterial Spot or Bacterium pruni Leaf and Fruit Spot. Much injury to peach foliage caused principally by sprays and low fertility of the soil has been attributed to bacterial spot. Bacterial spot, or black spot, affects fruit, leaves and twigs. The disease overwinters in infections in twigs which do not develop to any extent until spring. In the spring, after growth commences, bacteria are discharged from these cankers and infect the leaves and young fruits. The spots on the leaves are small, nearly black, and oily. The early ones are associated with twig cankers. The spots on the fruit are small, brown to black lesions, often with cracks across them. Experience in Kentucky as well as elsewhere indicates that the spot is rarely a factor in orchards growing in a fertile soil, but may cause severe injury in orchards on badly worn soils. Manuring and other forms of fertilizing tend to reduce the injury. Zinc sulfate spray has been recommended as a means of control, but its effect seems to be in stimulation of otherwise partially undernourished trees, and in preventing spray burn, rather than in direct control of the disease.

PLUM

In spraying plum, use the same spray schedule as for peaches. Special attention should be given to the curculio, as plum is the preferred host.

CHERRY SPRAY SCHEDULE

Time	Spray Mixture	For
1. Dormant	Oil emulsion 2% or Lime sulfur 1 to 8	Scale. Seldom necessary, omit if not present
2. Petal fall. Apply as soon as most of petals have fallen. Complete by time shucks start to fall	Lime sulfur* 1 gal. Lead arsenate 1½ lbs. Hydrated lime 3 lbs. Water 50 gals.	Leafspot Curculio Slugs
3. Two weeks after petal fall	Same as No. 2	Same as No. 2
4. Four weeks after petal fall	Lime sulfur* 1 gal. Water 50 gals.	Leafspot Brown rot
5. Immediately after harvest	Same as No. 4	Leafspot

* Dry lime sulfur may be used in place of the liquid at the rate of 4 pounds to 50 gallons of water for the summer applications. If leaf spot develops later in the season additional sprays will be necessary.

PESTS OF THE CHERRY

Leafspot. Leafspot is the chief limiting factor to cherry production in Kentucky. The disease lives over winter in old leaves on the ground and the first infections appear on the new foliage early in the summer. Some of the affected leaves turn yellow and drop, and sometimes the tree may be practically defoliated. This results in a weakened condition of the tree, failure to form fruit buds and susceptibility to winter injury. The fruit on weakened trees suffers in size, color, and quality. Spraying is an effective control measure. In dooryard plantings, raking and burning all leaves as they drop in late summer and fall, helps to keep the disease under control.

Brown Rot. Brown rot is seldom serious on sour cherries but is often destructive to sweet cherries about harvest time. Wet weather and high temperature favor rot.

Curculio may cause wormy cherries. Lead arsenate is used in sprays 2 and 3 for their control when present.

Aphids. If aphids are present spray with nicotine sulfate at the rate of ½ pint to 50 gallons of water, before the leaves curl. Use a spreader (two pints of liquid cocoanut oil soap or one pound of special hard soap spreader) unless combined with one of the regular sprays.

Slugs. These soft-bodied, slimy larvae which skeletonize the leaves are easily controlled by spraying with lead arsenate. The spray schedule takes care of them in the spring, but they may appear in late summer and fall.

Scale. Cherries are less subject to attacks of scale insects than most other fruits, but they are not immune. Dormant spray should be omitted unless scale insects are present.

GRAPE SPRAY SCHEDULE

Time	Spray Mixture	For
1. Dormant season	Oil emulsion 2%, or Lime sulfur 1 to 8	Grape scale or San Jose scale. Omit if no scale
*2. New growth about 1 inch long	Bordeaux 8–10–100	Black rot, mildew
3. Cluster breaking, 2 weeks after No. 2 or when shoots are 4 to 8 inches	Bordeaux 8–10–100	Black rot
*4. Preblossom, when first blossoms are opening	Bordeaux 8–10–100 Spreader (see note)	Black rot
*5. Postblossom, when bloom is nearly complete	Bordeaux 8–10–100 Lead arsenate 3 lbs. Spreader (see note)	Black rot Berry moth worms
6. Just before berries touch, or when size of pea	Bordeaux 8–10–100 Lead arsenate 3 lbs. Spreader (see note)	Black rot Berry moth Root worm beetle
7. June 22-25	Nicotine sulfate 2/3 pt. Soap 2 lbs. Water 100 gals.	Leaf hoppers

Notes

It is best to use a spreader, beginning with the preblossom spray. For 100 gallons use 1 pint of fish oil (refined for spraying), or 1 pound of soap chips made for spraying, or one quart of liquid soap.

Altho this spray schedule is designed for the commercial grape grower, it may be varied to suit conditions found in the home vineyard. Some may desire to use only the most important sprays. These are marked with an asterisk (*). Since black rot spreads from year-old canes to the young canes early in the spring, the delayed dormant spray should not be omitted where black rot has previously caused injury. The preblossom and postblossom sprays are most effective for the protection of the fruit. Black rot cannot be controlled successfully if spraying is delayed until the rot appears on the fruit. Thoro spraying with good pressure is important.

Protection by Sacking. In the garden the clusters may be protected by sacking, in lieu of the postblossom sprays. Sacking is not only protection from diseases, insects and birds, but is a means of producing perfect clusters of fruit for home use and for exhibition. The ordinary grocer's 2-pound manila sacks are satisfactory for most varieties, or 3-pound sacks for exceptionally large clusters.

PESTS OF THE GRAPE

Black Rot. This is the most serious disease of grapes in Kentucky. It is carried over from year to year on the old canes and is spread to the young shoots and leaves when growth starts in the spring. Infections on new canes a few inches long, appear to carry the fungus over to the following year. These should be prevented by an early spray. Infection of the fruit stems, even before bloom, may result in loose clusters. The first conspicuous appearance of rot is on the half-grown grapes, as small, black or brownish spots that enlarge rapidly. Finally the berry becomes shriveled and mummified. Since infection takes place several weeks before it can be observed on the fruit, sprays to be effective must be applied early. Dry weather dur-

ing the spring, when the spores are ordinarily spread, may prevent infection and this explains why there is little damage some years.

Berry Moth. This moth lays its eggs on the blossoms and a later generation lays eggs on the berries in midsummer. The first-generation larvae feed on the blossoms and small berries. The berries in the cluster usually are webbed together. The second-generation larvae feed on the inside of the berries. The berries develop purple spots, which may crack and rot. For this reason, the injury may be confused with black rot. Lead arsenate as recommended in the spray schedule usually is effective in control.

Grape Flea Beetles. In an occasional year the grape flea beetle, a glossy, greenish-blue insect somewhat under ¼ inch long, appears in destructive numbers upon the grape buds, eating the centers out of them. One and a half pounds of lead arsenate should be added to each 50 gallons of the delayed dormant spray, or cluster-breaking spray, if grape flea beetles appear.

Grape Leaf-Folder. The name is descriptive of the habits of the larvae of this little black moth. The larvae fold the leaves upward and skeletonize them by feeding on the inside of the folds. Lead arsenate used in the spray is effective. In home plantings where the grape leaf-folder is commonly found, hand picking of the folded leaves is recommended. Supplemental winter clean-up measures aid in its control.

Green June Beetle. This is a very annoying pest that attacks the ripe fruit and destroys the clusters. As the fruit is ripe at the time of the attack, arsenical sprays cannot be used. If the beetle is troublesome, the fruit should be picked as soon as ripe. Sometimes it is practicable to jar these clumsy beetles from the fruit into a pan of water and coal oil. Usually jarring must be repeated daily for several days. An excellent method of preventing damage from green June beetle in the home vineyard is to sack the fruit.

Leafhoppers. Several species of leafhoppers attack the grape in Kentucky. All are minute, triangular-shaped insects which pierce the tissues of the leaves and suck the cell sap.

When disturbed they fly in swarms. This is particularly noticeable in late July if an earlier spray has not been applied. The first evidence of leafhopper injury is small, whitish or yellowish spots on the leaves. In severe attacks the leaves become yellowish or brown and may fall. Leaf injury interferes with the proper ripening of the grapes and reduces the sugar content. The growth and vigor of the vines are reduced.

To control grape leafhoppers, use 2/3 pint of nicotine sulfate with four pints of a liquid soap spreader such as cocoanut oil soap (40%) or two pounds of hard soap spreader made for spraying, in 100 gallons of water. For 3 gallons use 1/3 ounce of nicotine sulfate with 3 ounces of liquid soap or 2 ounces of a hard soap spreader. Since the young insects (nymphs) do not develop wings until mature, spraying is most effective just before the oldest of the first brood develop wings. This period in Central and Eastern Kentucky is reached about June 22 to 25. In western Kentucky it frequently occurs a few days earlier. The young insects of the second generation begin to develop wings late in July. If the June spray was not effective or was omitted, a spray for the second-generation nymphs late in July will be necessary.

Commercial rotenone and rotenone combination sprays are also very effective. Tests in 1933 and 1934 at the Experiment Station, showed their effectiveness was about equal to that of nicotine-soap combinations but the cost greater. The rotenone sprays used contained a spreader of soluble pine oil. They were not unpleasant to use. They should be used as recommended by the manufacturer, as different brands have different rotenone and spreader content.

Rootworm. The adult is a beetle which feeds on the foliage and its work may be recognized by the chain-like marks on the leaves that result from its habit of feeding. The larvae feed on the roots, devouring the smaller ones and stripping the bark and eating out pits and furrows in the larger ones. The vines become stunted or may be killed. Since the adults feed on the leaves control consists in spraying with lead arsenate.

Scale. Grape canes may be attacked by two species of

scale, the grape scale, and the San Jose scale. Of these the San Jose scale is by far the most destructive. Both may be controlled by dormant spraying. Spraying is not recommended unless scale is present.

STRAWBERRY

Crown Borer. The grubs of the strawberry crown borer destroy plants of the cultivated strawberry, wild strawberry, the common wild cinquefoil or five finger, and Indian strawberry, by tunnelling into the crown during the spring and summer. In late summer and fall, the grubs transform to small, brownish snout beetles slightly larger than grape seed. These feed on the leaves until cool weather when they hibernate in rubbish and in the soil in and around the strawberry field. The adults have wings but do not fly. Eggs are laid in the crown of the plant, beginning with the arrival of warm weather in March and continuing until late spring.

Only young plants that have been inspected and passed by the state inspection service should be used in new plantings. Plants should be dug between November 15 and March 1. Immediately after digging, wash in running water, removing all dirt and dead and spotted leaves, and plant at once or "heel in" on crown-borer-free soil. It is never entirely safe to set new plants nearer than 100 yards from old plantings or wild host plants. Write the State Entomologist* for a list of plant growers.

Leaf Roller. The larva or caterpillar of the leaf roller feeds on the surface of the leaves a short time after hatching, then folds a leaf over itself and feeds on the protected surfaces until it transforms to an adult moth. There are three or four generations a year in Kentucky. Its destructiveness varies from year to year. The best control is obtanied by mowing and burning the fields immediately after harvest.

White Grubs. The thick-bodied, crescent-shaped white grubs, which destroy strawberry plants, are the larvae of the brown May or June bettle, and should not be confused with the

* W. A. Price, Experiment Station, Lexington, Ky.

grub of the green June beetle which crawls on its back, and feeds largely on dead organic matter. White grubs usually require three years for development, being most destructive during the second summer. As eggs are laid chiefly among grasses and weeds, control in strawberry beds may be had, in part, by planting on ground that has been used for a cultivated crop or a legume the two previous years.

Leafspot. Leafspot is not a serious pest on the two leading varieties, Aroma and Premier. The Blakemore is more susceptible. Leafspot may be held in check on the resistant varieties by removal of all affected leaves when new plantings are made, and by mowing and burning the planting immediately after harvest. If these methods are not effective on susceptible varieties, spraying with 3-4-50 Bordeaux mixture may be necessary. Sprays as follows are recommended: (1) As soon as growth is well started in the spring; (2) Repeat as often as necessary to keep the foliage well covered until the fruit is two-thirds grown; (3) One or two additional applications in late summer.

RASPBERRY

Leafspot. From a limited experience with Latham red raspberries, it appears that leafspot is the most injurious disease of this variety in Kentucky. Leafspot also affects black raspberries but does not cause extensive defoliation. Leafspot appears on Latham and Chief raspberries when the new canes are about 10 inches high and new infections occur after every rain. A group of leaves may become old enough, between rains, to be highly resistant, while the young, tender leaves immediately above them may be blackened and dried up by leafspot. By late summer new canes often are defoliated except for a few leaves at the tips. If new canes are tied to a stake, they may appear to have good foliage but when the strings are cut and the canes separated they may be found to be severely defoliated. It appears that extensive defoliation leaves the canes in condition so that the buds which develop the fruit spurs, and sometimes the entire canes, are killed during the winter.

CONTROL. Leafspot quickly enters new plantings, even those set entirely with plants from which the tops have been removed at digging time, unless the new planting is isolated from native brambles, when it may remain free from spot. The fungus evidently is carried by air currents from overwintering fruiting bodies on leaves of wild brambles. The fungus also overwinters on the canes; therefore these should be removed as soon as picking is finished. Spraying with 3-4-50 or 4-4-50 Bordeaux mixture, in 1933, was found to greatly reduce leaf injury and resulted in winter injury to only about 30 percent of the canes, whereas about 90 percent of the canes on unsprayed plants were killed. In 1933, when the disease was particularly severe before picking, a spray applied immediately after harvest and removal of old canes, followed by 2 more sprays at intervals of three weeks, appeared to give as good control as preharvest sprays followed by the postharvest sprays.

Anthracnose. This disease of black raspberries occurs on the one- and two-year-old canes, causing grayish spots with purplish borders, 1/8 inch or more in diameter. The older lesions extend into the sap-conducting tissue. The numerous cankers of the canes partly girdle them, resulting in small, shriveled fruits which sometimes dry before ripening. The fungus overwinters on canes from which it is spread to the new shoots by washing rains. The fungus causes superficial spots on Latham raspberries, but there is no evidence that it causes extensive injury.

TREATMENT. New plantings of both reds and blacks should be set with clean stock or plants from which all above-ground parts have been removed before the plants are taken to the field. Black raspberries should be planted when dormant, for if new shoots have appeared above ground at digging time, infection of leaves and stems may already have taken place. Old fruit canes should be removed immediately after harvest and severely infected new canes may be removed at the same time. Freedom from weeds is essential to good control.

For black raspberries and blackberries a delayed dormant

spray of liquid lime sulfur, 1 to 10, or Bordeaux mixture, 4-4-50 (with calcium caseinate 1 pound to 100 gallons, as a sticker, or with one of the other spreaders discussed under soap spreaders) applied when the leaves first begin to show green, is effective most years. In wet seasons and in severe infestations, a second spray of Bordeaux, 4-4-50, applied not later than a week before the blossoms open, may be necessary.

Red Spider. For control of the red spider use one per-cent of summer oil emulsion in a 3-4-50 Bordeaux mixture, in place of the lime sulfur for the delayed dormant spray.

CURRANT AND GOOSEBERRY SPRAY SCHEDULE

Time	Spray Mixture	For
Dormant	Oil emulsion 2% or Lime sulfur 1 to 8	Scale when present
Two weeks after full leaf	3–4–50 Bordeaux mixture Lead arsenate 1 lb.	Leafspot Worms
After harvest	3–4–50 Bordeaux mixture	Leafspot